UNITED STATES TARIFF COMMISSION
WASHINGTON

INFORMATION CONCERNING

The Magnesite Industry

PRINTED FOR USE OF

COMMITTEE ON WAYS AND MEANS

HOUSE OF REPRESENTATIVES

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Office: 1322 New York Avenue, Washington, D. C.

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LETTER OF TRANSMITTAL.

UNITED STATES TARIFF COMMISSION,
Washington, June 11, 1919.

The Committee on Ways and Means of the House of Representatives:

I have the honor to transmit herewith, in accordance with your request, information compiled by the United States Tariff Commission on magnesite, crude and calcined.

Very respectfully,

THOMAS WALKER PAGE,
Acting Chairman.

CONTENTS.

THE MAGNESITE INDUSTRY.

INTRODUCTION.

Magnesite is a natural carbonate of magnesium. When pure it contains 52.4 per cent carbon dioxide (CO_2) and 47.6 per cent magnesia (magnesium oxide MgO). It is harder and heavier than limestone which it most nearly resembles. Two markedly different natural varieties are distinguished, crystalline and massive.

The massive is a chalk-white, compact, fine-grained variety usually found in veins or masses in serpentine rocks, while the crystalline is blue, red, and gray, medium or coarse grained, and occurs only as masses in altered limestone. The only important crystalline deposits are found in Austria-Hungary (Styria), Quebec, and Washington. Massive magnesite is widely distributed.

Magnesite when calcined forms a highly refractory material which has no thoroughly satisfactory substitute in the open-hearth process for making steel. About 82 per cent of the domestic consumption is used in refractories, 15 per cent in the plastic trade, and the remainder is required in minor uses in chemical industries and medicines.

SUMMARY OF THE DOMESTIC SITUATION.

The United States is the largest consumer of magnesite in the world. Its consumption in 1913 was 50 per cent of the total output of the world. Before the war, fully 90 per cent of the domestic supply was imported. Austria-Hungary furnished the bulk of the material required by the steel industry, while Grecian deposits supplied most of the requirements for other purposes. The only domestic production was in California, where it was consumed locally.

With the outbreak of the war, supplies from Austria were at once cut off and, after 1916, those from Greece were greatly curtailed. At the same time the domestic requirements increased greatly. In 1917, the domestic consumption was over 355,000 tons, valued at more than $3,700,000. Nearly 90 per cent of the supply was of domestic origin. A great new industry was developed in Washington while the existing industry in California was greatly expanded. Similarly fostered by the restriction of ocean shipment, a magnesite industry sprang up in Quebec and, in spite of the inferior quality of the product, was a strong competitor of the western magnesite because of its relative cheapness at the eastern steel furnaces.

The chief handicap of the domestic magnesite producer is the long railroad haul from the mines to eastern markets, where it is chiefly consumed. Domestic reserves are ample, especially in Washington,

where more than 7,000,000 short tons are indicated or in sight, and they have been actively exploited by two or three strong companies and several small operators.

The American magnesite is purer than the Austrian material, which, by virtue of its content of a small amount of iron in just the proper amount, is better suited by nature for use in the steel industry. The early difficulties encountered in the use of domestic material, however, have been quite satisfactorily overcome. The lack of the desired amount of iron in Washington magnesite is made up by adding iron synthetically.

With the return of normal shipping conditions, the American magnesite industry faces the prospect of a serious relapse—almost to the prewar level. Recently developed deposits in Venezuela may be expected to furnish some material to the eastern markets in competition with that from Greece and Canada, but Austrian magnesite will dominate the market if delivered at anything like prewar prices, which were as low at the Atlantic seaboard, practically the point of consumption, as quotations of the domestic product on the Pacific coast. Under these conditions, the domestic output would be restricted to the markets west of the Mississippi where the consumption is comparatively small. The precise location of the definitive line is dependent upon the balance of ocean freight from foreign countries and domestic rail tariffs from the Pacific coast, but the advantage lies with the foreign producer, due to the concentration of the steel industry in Pennsylvania, Illinois, and neighboring localities.

Summary table.

Calendar year.	Domestic production (short tons).	Imports for consumption (short tons).[1]	Domestic exports.	Ratio of imports to domestic production. (per cent)	Value (imports for consumption).[1]	Amount of duty.	Value per unit of quantity.[2]
1910	12,443	323,654	None....	2,610	$1,542,800.00	Free....	$6.25
1911	9,375	257,124	...do.....	2,740	1,185,867.00	...do.....	5.86
1912	10,512	268,408	...do.....	2,550	1,369,665.00	...do.....	5.83
1913	9,632	347,426	...do.....	4,020	1,757,476.00	...do.....	6.40
1914	11,293	256,987	...do.....	2,280	1,377,871.00	...do.....	4.10
1915	30,499	102,913	...do.....	337	487,211.00	...do.....	5.12
1916	154,974	93,885	...do.....	61	838,630.00	...do.....	8.42
1917	316,838	38,208	...do.....	12	464,706.00	...do.....	7.66
1918	225,000	41,148	...do.....	18	927,255.00	.....	19.60

[1] Quantity of imports of calcined have been doubled (assuming a 50 per cent loss in weight because of the calcining operation) and added to quantity of crude. Values of calcined simply added to those of crude in this table.

[2] Based on imports of crude only.

MARKET GRADES AND USES.

Magnesite is marketed either (1) crude or (2) calcined. Crude magnesite is the material as mined except that it may be sorted or undergo a simple cleaning operation to remove admixed rock waste. A very small use of the crude material is as a substitute for barite in paint manufacture. Some is made into magnesium salts; but practically all the product is calcined; yielding, according to the temperature, either caustic or dead-burned magnesia.

(*a*) *Caustic magnesia* (moderate temperatures) in which most of the carbon dioxide is driven off, but from 3 to 8 per cent is inten-

tionally left in the residue. In this form the residual magnesia reacts readily with water and carbon dioxide in the air (compare quicklime) and readily combines with various acids for the manufacture of salts. Mixed with magnesium chloride (which may be made from magnesite and muriatic acid, but which is generally derived as a by-product in salt manufacture), caustic magnesia is made into Sorel ("oxychloride") cement. This mixture, generally modified by the addition of various filler materials (wood-flour, cork, talc, silica, asbestos, clay, marble dust, sand, etc.) together with suitable coloring matter is sold under various trade names. It is one of the best floorings. The use of magnesite cement in floors and as stucco and wall or outside plaster is gaining importance. It sets much quicker than Portland cement and has the peculiar advantage of great resiliency. As the determining factor in ordinary floors is the deflection under load, the large deflections possible with this material permit lighter and cheaper building frame construction. Calcined magnesia is also used in making magnesium bisulphite for disintegrating wood pulp in paper making.

(*b*) *Dead-burned magnesia* (heated to incipient fusion) in which the last traces of carbon dioxide have been removed and the material heated to the point of incipient fusion. In this state, it will not slake or combine with chemicals. It is largely used for basic open-hearth steel furnaces, convertors, and kilns for sulphuric acid (pyrites) burning, and in electric furnaces. Dead-burned magnesia comes in the form of brick and grains.

(*c*) *Carbon dioxide* may be saved, but only when caustic product is to be made. The character of the calcination for the production of dead-burned magnesite is not suited to the recovery of gas.

(*d*) *Metallic magnesium, magnesium oxide and salts* are rarely made from magnesite. In most cases a supply of by-product magnesium chloride is more cheaply available and the use of magnesite for these purposes is exceptional. Magnesia for chemical and medicinal use as well as pipe covering material, light carbonate and other products come in this class.

SUBSTITUTES.[1]

High magnesian dolomite is a material that has proved to be a fairly satisfactory substitute for magnesite in many classes of metallurgical work. It is much cheaper and far more widely distributed, but is not so refractory. Slight changes (high lime slags) in furnace processes are often necessary in using this material. Locally, serpentine rocks are possible sources of magnesium and its compounds while magnesium salts are by-products of the common salt and potash salt industries. Bauxite is another basic refractory material and may take the place of magnesite in certain classes of metallurgical work. Patented products consisting of dolomite treated with furnace dust and roasted—"kendymag," "syndolag," and "magnibrent"—have come into more or less satisfactory use at steel plants.

[1] In 1913, 178,530 tons of calcined magnesite were consumed in the United States; in 1917, 177,524. For the large increase in steel made in 1917 over 1913, the difference was largely made up by use of dolomite.

TARIFF CLASSIFICATIONS.

Both caustic and dead-burned magnesite are included as "calcined" not purified and are classed with crude magnesite under paragraph 539 on the free list (act of 1913). Similar materials are magnesite brick (par. 71) which comes under other refractories and differs from dead-burned magnesite only in having been molded into definite forms subsequent to calcination.

In the chemical schedule (par. 42) "magnesia: Calcined, and carbonate of, precipitated" are listed as dutiable, while conceivably these products accord closely in chemical composition with calcined and crude magnesite. The intent of the act is clear in that they are (generally purer) products produced by chemical processes from magnesium salts, especially those from Stassfurt, Germany.

DOMESTIC PRODUCTION.

The maximum domestic production of magnesite was in 1917 when the total output amounted to 316,838 short tons and was valued at $2,899,818 at the mines. The 1918 production was on a somewhat reduced scale due to competition from Canada, and a more general use of substitutes (notably burnt dolomite in some of the eastern metallurgical plants and even in the paper trade).

Magnesite has been produced in the United States since 1891. Prior to the outbreak of the European war, California was the only producing State. The total output, averaging less than 10,000 tons, was consumed locally, chiefly in the manufacture of paper. In 1913 and 1914 a small amount was taken by makers of stucco and Sorel cement, especially for use in the buildings of the Panama Pacific Exposition.

The first magnesite produced in the State of Washington was 715 tons mined in December, 1916. In 1917 the State yielded 105,000 tons and the estimated production for 1918 indicates that this State will show a larger output than California.

Production in United States.[1]

[From Mineral Resources, U. S. Geological Survey.]

	Quantity (short tons).	Value.		Quantity (short tons).	Value.
1900	2,252	$19,333	1913	9,632	877,056
1904	2,850	9,298	1914	11,293	124,223
1909	9,465	37,860	1915	30,499	274,491
1910	12,443	74,658	1916	151,971	1,393,693
1911	9,375	75,000	1917	316,838	2,899,818
1912	10,512	84,096	1918	[2] 225,000	

[1] Prior to December, 1916, California was the only producing State.
[2] Estimated.

DOMESTIC RESOURCES AND LOCALITIES OF PRODUCTION.

Magnesite occurs in commercial quantities in California, Nevada, and Washington. Reports of workable deposits in other States have not been verified.

Domestic production by States.

[From Mineral Resources, U. S. Geological Survey.]

MAGNESITE, CRUDE OR CALCINED, NOT PURIFIED.[1]

States.	1916		1917	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.
California	154,259	$1,388,331	211,663	$2,116,630
Washington	715	5,362	105,175	783,188
Total	154,974	1,393,693	316,838	2,899,818

[1] Prior to 1916 California was the only producer.

California.[1]—Magnesite deposits occur in numerous localities throughout the Coast Range and on the west slope of the Sierras, from Mendocino and Placer Counties on the north to Riverside County on the south. In nine counties the deposits are large while in four counties only small deposits have been found. In 1917, 63 per cent of the crude magnesite produced in the State came from Tulare County. The rest of the production came from widely separated deposits.

With one exception (Bissell, Kern County) all the California magnesite deposits occur as irregular veins, lenses, masses, or stock work in serpentine rock. In a few places the veins or masses are 20 feet or more in width but more generally the veins are narrow and separate lenses are irregularly disposed.

Washington.[2]—Deposits of crystalline magnesite have been found in several sections in the northeastern part of Washington (Stevens County) about 60 miles north of Spokane. The Washington magnesite differs markedly in character from the California material and is found in large masses. The larger deposits are 200 or more feet thick and 1,000 or more feet long. Estimates of 1,000,000 tons, each within 100 feet of the surface, are reasonable for at least three of the deposits.

Most of the Washington magnesite is colored, generally rather dark, and its grade must be determined by chemical analysis, as it can not be judged by its appearance.[3] It is considered better for refractory purposes than the California grade, but the latter is preferred for building purposes.

A plant for making magnesite brick was built in Washington in 1917.

INDUSTRIAL DEVELOPMENT.

At the outbreak of the war the California industry was established quite firmly on the basis of medium-scale production and simple marketing systems, largely contractual. Since the freight rate on calcined magnesite is the same as that on crude and the product weighs only about one-half as much, practically all the ore was calcined at the mine. Various types of kilns were in operation.

[1] For further description see Bull. 355, Magnesite Deposits of California, F. L. Hess 1918; Bull. 540-s, Late Developments of Magnesite Deposits in California, by H. S. Gale; and recent chapters of Mineral Resources, U. S. Geological Survey.

[2] A description of magnesite deposits in Washington was published in the Eng. and Min. Jour., Apr. 13, 1918; also in Mineral Resources (1917), U. S. Geological Survey.

[3] Letter from H. F. Wiegum (Aux. File) states "Washington caustic" cream-white.

Most of them were of the vertical type, similar to those used for making quicklime—inexpensive to build, but rather wasteful of fuel. Crude oil was used at many plants, but in the more isolated sections wood was cheaper. The character of the California deposits was such that extensive installation of equipment was not warranted. Single mines rarely remained in steady operation for any great length of time and no very large reserves were proved in advance of mining. At the end of 1913 there was only one producing company; in the whole year only three companies had operated. Early in 1914, however, several old mines were reopened and a few new producers came in. The only large producer at any time before the war was the Tulare Mining Co., and almost its entire product was contracted for by the Crown Willamette Paper Co. Only a few hundred tons surplus came on the open market. This was sold to grinders in San Francisco, who retailed it to consumers. The more or less sporadic output of the smaller organizations—none of whom could have guaranteed an output of 500 tons a month—came on the market almost wholly in granular form ("caustic") and in bulk.

War stimulation of the industry came in the latter part of 1914. It affected the larger properties first, but soon there was a rapid development of new producers. Mines, 20 miles from the railroad, that had never been commercially considered, were opened up and contributed to the output. One producer installed one and later another large rotary kiln similar to those employed for cement burning and improved its equipment generally. Broadly speaking, however, the California industry responded to the increased demand for its product by multiplying the number of producers—16 of whom reported production in 1915 [1]—rather than by greatly expanding individual operations.

In Washington, however, the somewhat greater inaccessibility of the deposits and their much greater indicated extent offered more attractions to large capital than to individual operations. The largest producer in the field is the Northwest Magnesite Co., which claims to have expended about $1,000,000 on equipment and developing work.

Only four companies, but two of which are now (1918–19) operating, took part in the development of the Washington industry. The extraordinary progress made in the first two years of operation is ample evidence of their enterprise and financial strength. A large part of the work done by these companies was purely development. The deposits are several miles from a railroad and the early operations involved hauling by wagon and motor truck. A year after opening their major deposits the largest producer completed a 5-mile aerial tram from the quarry to its new calcining plant, where three rotary cement kilns, 125 feet long by 7½ feet diameter, are installed. Both quarrying and calcining operations are fully equipped with modern machinery and labor-saving devices. The management is evidently able and aggressive, and backed by ample capital. The latest development is the addition of iron ore, in correct proportions, at the calcining plant for the production of "ferromagnesite," of similar composition to the Austrian material, and that is claimed to be quite as satisfactory as the Austrian product for refractory purposes.

[1] Sixty-five in 1917.

DOMESTIC CONSUMPTION.

The consumption of magnesite shows a marked increase, and there is promise of a still further development in the next few years. In 1917 the apparent consumption, expressed as crude, was over 355,000 short tons, or about 25 per cent more than the consumption just before the war. The United States is the largest consumer of magnesite, and in 1913 its requirements amounted to over 65 per cent of the total world consumption, if 500,000 tons[1] is considered as the world output for 1913. This quantity includes only exports from Austria-Hungary, and it is presumed that Germany, the second largest steel producer, must have used 150,000 to 200,000 tons of magnesite, and that the world's output was nearer 700,000 tons. If this is true, the United States used about 50 per cent of the world's production of magnesite.

A recent estimate of the character of the consumption is that 82 per cent is used as refractory, 15 per cent in the plastic trade, and 3 per cent for chemical and medicinal purposes. The open-hearth steel industry is the most important factor in the magnesite situation. While this industry is not wholly dependent on magnesite supplies, it is largely so. The partial substitution of dolomite, however, has come to stay and the amount of magnesite consumed per ton of basic open-hearth steel, which formerly was 6 to 14 pounds (dead burned), has lately been cut almost in half. The total amount used by the steel industry has not decreased on account of the much greater output of basic open-hearth steel. The use of magnesite in building trades has also increased to a marked extent.

SOURCES OF DOMESTIC SUPPLY.

Over 90 per cent of the domestic supply of magnesite before the war was imported. The preponderant supply—and practically all that used in steel manufacture—was derived from Austria-Hungary. No other foreign sources of large supply of a satisfactory quality of material existed. The Grecian deposits furnished only "caustic" for use in plastic grades and in the manufacture of chemicals and heat-insulating material.

In 1917, however, the proportions were reversed and over 90 per cent of the domestic supply came from American deposits. The tendency in 1918, however, was toward largely increased importations of Canadian material. If there had been no restrictions on ocean shipments of this material (in the interest of ship saving), there would also have been large importations from Venezuela.

DOMESTIC COSTS OF PRODUCTION.[2]

Crude.—At present in the State of California, magnesite of superior quality can not be delivered f. o. b. railroad point for less than $8 a ton and allow any margin of profit to the operator. Average cost of mining is $5 a ton, delivery costs $1, and when royalties, overhead and general expense, equipment, etc., are considered, the margin of profit is low at the above figure. Washington crude is offered f. o. b. railroad cars, 1919, at $4.50 per ton.

[1] Private communication from U. S. Geological Survey.

[2] About September, 1918.

Calcined.—In former years the bulk of shipments from California have been crude, but now there are a number of up-to-date calcining plants in California that are sending finished product to eastern market. Cost of calcining at present price of oil and labor was about $4.50, using rotary kilns. In upright or vertical kilns using coke or oil, the cost ranges from $6 to $7 per ton calcined.[1] Sworn statements of domestic costs appear in auxiliary file.

Freight.—Present transcontinental freight rate on magnesite is the same for crude or calcined material. To Chicago or group D points (roughly all the territory west of the Mississippi and inclusive of the States of Illinois and Indiana) is $10 per ton in carload lots. To Pittsburgh, Philadelphia, and neighboring territory the rate is $11,[2] while to New York and far eastern points, $12.50.[2] On account of the low value of the material it is probable that freights will be reduced if it shall be found necessary to meet European competition.

FOREIGN PRODUCTION.

Developed magnesite deposits outside of the United States that have been productive are located in Quebec and British Columbia (Canada); Santa Margarita Island, Lower California; Venezuela; Austria-Hungary; Greece; Norway; Spain; Germany; Russia; Macedonia; Transvaal; and India. Deposits, some of which have produced small amounts, are located in Ontario and New Brunswick, Canada; Cedros Island, Lower California; Asia Minor; Sweden; Rhodesia; Portuguese West Africa; Australia; China; Japan; Tasmania; and New Caledonia. The largest foreign producer has been Austria-Hungary, with Greece second. The production of other countries was of minor importance until the war resulted in cutting off the Austrian supplies from all but the Central Powers. The cutting off of these supplies caused stimulation chiefly in the North American output. There is little reason to expect that there will be any marked shift in the important sources of supply although the relative importance of the major producers may undergo considerable readjustment.

Magnesite reserves of the world.

[Communication from Mineral Resources Division, United States Geological Survey.]

	Short tons.
Austria-Hungary	120,000,000
Greece	5,500,000
Washington	7,000,000
California	750,000
Venezuela (Margarita Island)	[3] 3,200,000

The indicated reserves of the two American producing States are included for comparison. The reserves in other countries have not been measured and no even approximately accurate estimate can be made as to the total resources of the world.

[1] Burning $9 to $10 per ton, American Mineral Products Co., cost, 1919 (Washington).
[2] New rates, June 25, 1918, $15.60+47 cents per short ton, Spokane to Atlantic points; $13.80+41 cents to Pittsburgh.
[3] Caracristi, Chas. F. Z., Eng. and Mg. Jl., 107 (1919), p. 645.

FOREIGN RESOURCES AND COUNTRIES OF LARGEST PRODUCTION.[1]

The foreign countries that enter into the American magnesite situation are Canada, Austria-Hungary, Greece, Mexico, and Venezuela. Small exports have been made from countries other than those named, notably Norway (via Scotland) but they are not of sufficient importance to warrant discussion with reference to the United States. The production of the more important countries are given in the following table:

Production in principal foreign countries.[1]

[In metric tons.]

	Austria-Hungary.[2]		Greece.		India.	Spain.[3]
	Crude.	Calcined.	Crude.	Calcined.	Crude.	
1903	.....	69,058	28,415	.....	838	.....
1904	.....	53,781	9,133	.....	1,193	.....
1905	.....	92,359	37,063	.....	2,645	1,446
1906	.....	87,765	40,584	.....	1,861	1,335
1907	452	113,695	55,816	.....	188	1,954
1908	212	87,049	63,079	.....	7,655	.....
1909	1,027	125,666	56,797	16,609	199	.....
1910	341	182,911	18,073	19,982	5,264	.....
1911	77	[4] 182,911	86,956	27,530	3,546	.....
1912	.....	171,196	106,338	33,848	15,626	1,480
1913	.....	200,947	98,517	31,815	16,468	958
1914	.....	.....	136,701	28,563	1,706	583
1915	.....	.....	159,981	[4] 28,563	7,570	1,400
1916	.....	.....	199,484	27,548	17,924	.....
1917	.....	.....	.....	69,837	.....	.....

[1] Mineral Industry.
[2] Exports.
[3] Redlich, Fortsche d. Min. 4, pp. 9–42, 1914. Estad. Mineraria de Espana 1912–1915.
[4] Sic.

Austria-Hungary.—The magnesite deposits of Austria-Hungary follow a belt that extends in a northeast line across the two countries. The workable deposits are in the form of lenses. Only 10 or 12 of these lenses are of sufficient size to be worked but several of these are of large size. The largest deposit in the group is near the town of Veitch. It has been worked longer than any of the others and a huge quarry is located there. The magnesite forms an isolated lens in a high hill surrounded by barren rock. From the top to the bottom of the workings is 700 to 800 feet. The quarry face is carrird in benches about 50 feet high. Another large deposit in Austria is at Radentheim on the north side of the Millstatter Alps, where the material is quarried by great cuts and lowered by gravity to rotary kilns. This deposit was owned by an American company and much of the output came to United States ports. Both grain magnesite and magnesite brick were produced very near the mine. Another American company operated in Austria-Hungary before the war, but both properties were taken over by the Government and operated, at least for a time, by Russian prisoners. Two of the larger local companies sold all their export product through a German firm.

[1] Much valuable data in regard to the deposits and the industry in the several countries is available in the Auxiliary File of the Tariff Commission and in "Political and Commercial Control," Bull. 3, U. S. Bureau of Mines, by R. W. Stone.

Because of the huge size of the Austrian and Hungarian deposits, and their comparative accessibility and the low wages,[1] the product can be marketed cheaper than any other known supplies. Even the best deposits in these countries contain a large quantity of dolomite and quartz gangue that must be sorted out by hand. But the extraordinary opportunity for cheap mining and the ease with which it may be calcined to a dead-burned state, give these deposits a remarkable advantage over those of any other part of the world.

American capital is invested in the Austrian industry (to an extent not ascertained).

Greece.—Grecian magnesite is of the noncrystalline or amorphous type like that of California. The most important deposits are those of the island of Eubœa where they are all found close to the seashore. Cheap water transportation to all the principal consuming markets is available (under normal conditions). The largest veins are 50 feet or more wide and several hundred feet long.[2] They are mined by open cuts and a very pure product is obtained by cobbing.

In 1914, the production was mainly in the hands of three companies and practically all the product is distributed through one of them—a British company. Less than 2 per cent of the ore is dead-burned on the island and only about one-third of it is calcined before shipment. Before the war, much of the crude material was shipped to northern Germany or Holland where it was calcined and, in part, ground and packed for reexport, as prepared "caustic" for making Sorel cement. There has been some criticism of the Grecian caustic as delivered in the United States on account of its lack of uniformity. There is no reason why it should not keep practically indefinitely when properly packed. Magnesite from Greece and California are practically identical, but previous to 1915 the California material could not compete with the Grecian ore, much of which came in as ballast, because of high transcontinental freight.

Canada.[3]—The only important magnesite-producing district in Canada is Grenville, Quebec. Many other occurrences are reported. There are deposits of considerable extent in various parts of British Columbia, but, on account of the cost of transportation, are not workable at the present time.

The magnesite in the Quebec deposits is mixed with dolomite and serpentine, and the product invariably is high in lime. However, they have an advantage over the American deposits on account of their location close to centers of consumption, and increasing amounts are imported into the United States at lake ports and along the St. Lawrence. The Quebec quarry deposits are also cheaper to mine than those of California. The Canadian geological survey reported in March, 1917, that the cost of Grenville magnesite laid down in the principal markets was from one-half to two-thirds that of the California product (presumably referring to crude). This advantage was expected to be further improved by construction of tramways from the deposits to the railroad. Canadian material can not be used for the manufacture of the best magnesite brick. Material for brickmaking must be rigidly limited as to lime content (6 per cent)

[1] Austrian women, at 20 cents per day (1918) and men at 40 to 50 cents per day are employed.
[2] Veins of this size not common, however.
[3] Canadian deposits are fully described by Wilson: Magnesite Deposits of the Grenville District. Canadian Department of Mines, Memoir 98.

and silicon content (7 per cent). The Canadian material is suitable, in the main, only for grain manufacture (furnace bottoms).

Mexico.—On the island of Santa Margarita, in Magdalena Bay, there are extensive deposits from which exports have been made to the United States. It is a mountainous island cut up by canyons in which massive magnesite several feet thick is exposed. Boulders of the material strew the stream beds. Hundreds of thousands of tons are said to be in sight, and large quantities can be obtained with no expense for mining, requiring only to be broken up for shipment. Some of this material was being calcined in California in 1917, but the boat that carried it was diverted to other uses by the United States Government. The material is exceptionally pure, and the operations were conducted by Americans.

Venezuela.—Large deposits of the massive or California type are found on Margarita Island, off the coast of Venezuela. In 1915, 500 tons were exported to the United States. During most of the year the United States Shipping Board refused to grant a license for further shipments. Mines are developed sufficiently to produce 2,000 tons monthly of very high-grade material. During 1917 the output was about 10 tons a day and brought an average of $25 a ton, of which $19.50 was paid out for freight. The properties are operated by residents of California.

COMPETITIVE CONDITIONS.

DEPENDENCE ON TRANSPORTATION.

The important feature of the magnesite industry is its absolute dependence on cheap transportation for the successful exploitation of its product. Carbonic-acid gas bottlers were forced to resort to limestone in place of magnesite in California, largely because freight from mine and quarry to manufacturing plant more than offset the advantages of the richer (in gas) material. For this reason shipments of crude are restricted to very short hauls. Crude has, in fact, almost wholly disappeared from the city markets. The sudden increase in production in 1915 resulted in some resumption of shipments of crude magnesite from the mines, but these ceased as soon as kilns could be constructed at the new mines.

The freight rates by rail from San Francisco to Chicago just before the war were $10 a ton; to Illinois and Ohio points, $11; and to Pittsburgh and beyond, $12. The average price of domestic crude in the San Francisco market was about $8 per ton. The average import valuation of Grecian magnesite (which was more strictly competitive with the California product than the Austrian) was $7 to $8 per ton on board steamer in New York. Under free competition the definitive line of equal price was invariably west of the Mississippi River. Since the largest markets are in the Eastern States the domestic output was restricted to the rather limited local market in California on a purely cost basis. Calcined (not ground) Eubœan (Grecian) magnesite was usually sold in New York cheaper than was similar material at the mines in California. The competitive status of Austrian supplies was also dependent on the freight, since the dead-burned product in New York was even cheaper than Grecian "caustic."

A freight rate of $4 a ton from San Francisco to points on the Atlantic seaboard through the Panama Canal was quoted when the canal was first opened, but was later increased to $7 as the scarcity of bottoms became apparent. Eastbound magnesite, however, was never sought by carriers.

When the supplies of Austrian magnesite were finally cut off the California producers became a factor in the eastern market and for a time were practically free from outside competition. Later, however, Canadian deposits were developed, and although the material contained much more lime than the domestic product and was consequently less desirable for open-hearth steel production, it was so much cheaper because of the relatively short haul that it became an important rival of the Pacific coast product. Washington deposits were discovered and opened up in 1916, and largely supplied the market for refractory material in 1917 and 1918.

QUALITY OF PRODUCT.

While the chief handicap to the domestic producers is their distance from the points of consumption, the extreme purity of the product also had an important bearing on the situation. It is commonly assumed that the most refractory magnesite is the dead-burned calcined form (either as brick or in grains) containing little or no lime, silica, iron oxide, or alumina. Lime has a tendency to cause disintegration and also in steelwork may "become rotten," due to absorption of phosphorus that should have gone only into the slag. All the other impurities have a tendency to lower the melting point. On the other hand, there is a decided preference among refractory users for the magnesites that carry a certain percentage of iron as do the Austrian and Hungarian products. While the small amount of iron present does lower the melting point slightly, brick and other calcined products made from it are more satisfactorily burned and hold their shape better when exposed to high temperature. The shrinkage is less, and less heat is required for satisfactory calcination than is the case with the purer American material. In order to meet this condition, at least one of the American producers has installed mixing devices for adding iron ore to its product prior to calcination.[1]

Another feature that may be mentioned under this head is the preparation of the material. Even before the war, Grecian magnesite was sold in California in competition with the domestic product for the plastic trade and at a higher price. Discounting the prejudice or established custom of calling for "Grecian" magnesite in specifications, the greater diversity of forms and packages in which the imported product was available and the fact that it could be bought in small lots was a strong factor in its continued sale. The domestic producers invariably sold only in car-load lots. Very little of their product was marketed in the ground condition ready for use. On the other hand, the imported material was ground, of uniform grade, and packed in paper-lined barrels.

[1] Two California deposits contain enough iron so that magnesite brick are made without the addition of that material. It is claimed that eventually this purer American material will be regarded as a more satisfactory refractory than the Austrian product.

IMPORTS.

COUNTRIES OF ORIGIN.

The Department of Commerce publishes the countries of origin for importations of calcined but not of crude magnesite. In general, it may be said that Greece furnished a larger proportion of raw magnesite before the war than did Austria-Hungary. Raw magnesite has also been imported quite steadily from Canada in late years. The irregular imports from Mexico and Venezuela have been mentioned above, as has also the character of the importations from the various countries.

Most of the prewar importation of calcined magnesite from Netherlands, Belgium, Germany, and even the United Kingdom consisted of reexported Grecian "caustic," generally after calcining and repacking in those countries. Part of the imports from Great Britain (Scotland) was of Norwegian origin.

Imports by countries.

MAGNESITE: CALCINED, NOT PURIFIED.

Imported from—	1910		1911		1912	
	Pounds.	Dollars.	Pounds.	Dollars.	Pounds.	Dollars.
Austria-Hungary	203,501,826	919,470	286,784,390	1,282,298	198,208,783	916,550
Germany	5,437,213	23,616	2,851,020	18,474	1,378,678	16,600
Netherlands	3,424,636	35,263	5,948,054	59,608	4,819,284	52,806
Belgium			65,230	667	51,211	530
Greece	1,854,161	10,547			227,276	1,173
Norway	55,997	356	242,716	1,648	325,760	1,893
United Kingdom	819,120	7,401	5,560	36	123,192	1,062
Canada	26,000	239	591,940	1,726	467,920	2,863
All other			55,777	533	276,880	986
Total	215,118,953	996,892	296,544,687	1,364,990	205,878,984	994,463

	1913		1914		1915	
	Pounds.	Dollars.	Pounds.	Dollars.	Pounds.	Dollars.
Austria-Hungary	327,430,519	1,564,234	268,520,275	1,298,136	104,171,512	523,905
Germany	4,823,513	40,833	5,156,102	42,146	1,444,691	16,417
Netherlands	9,015,619	100,175	8,380,349	107,261	7,108,042	101,513
Belgium			22,310	289		
Greece	3,208,176	17,462	6,464,400	20,070	8,873,777	47,511
Norway						
United Kingdom	2,789	47	26,508	654	560,563	16,381
Canada	700,630	5,097	808,650	3,300	1,895,424	14,065
All other			115,722	1,351	2,641,421	25,590
Total	345,181,246	1,727,848	289,494,316	1,473,207	126,695,430	745,382

	1916		1917		1918	
	Pounds.	Dollars.	Pounds.	Dollars.	Pounds.	Dollars.
Austria-Hungary						
Germany	24,802	365				
Netherlands	3,899,359	59,155				
Belgium						
Greece	22,825,795	136,701	3,584,000	28,032		
Norway	44,840	611			22,046	482
United Kingdom	698,100	31,553	1,568,424	86,224	1,864,794	105,507
Canada	4,879,714	54,383	4,296,393	67,781	21,608,707	443,538
All other					4,242	200
Total	32,372,610	282,768	9,448,817	182,037	23,499,789	549,727

QUANTITIES.

The proportion of magnesite imported raw showed a gradual falling off from more than one-half the weight of the magnesite imported as calcined in 1902 (the first year for which separate statistics are published) to about one-twelfth the weight of calcines imported in the years immediately preceding the war—a natural result of established routes and the tendency to ship in the lightest possible form. The amount of calcined magnesite imported in 1914 was nearly 150,000 tons, valued at $1,500,000, or more than five times the quantity imported in 1904. On the other hand, the 11,000 tons of raw magnesite imported in that year was an actual reduction from the annual importation a decade before.

When the war first cut off the importation of Austrian calcines, a much larger proportion of raw material was imported, since no other country had sufficient calcining facilities to immediately take care of the sudden demand. Even some of the Grecian magnesite that ordinarily would have been calcined in Europe en route was shipped direct and the imports of raw magnesite from that country greatly increased as also did those from Canada later. In 1917 the importation of crude magnesite was the largest on record, both as regards quantity and value, amounting to nearly 90,000 tons, valued at $750,000, or nearly nine times the amount and sixteen times the value of the 1914 imports. In the fiscal year the imports of calcine reached their minimum—less than 5,000 tons, valued at only $182,000, or less than one-thirtieth of the amount and about one-eighth the value of the 1914 imports. In 1918 the import restrictions of the United States Shipping Board cut down the amount of crude magnesite imported to one-tenth that imported in the previous year. Increased rail and lake boat shipments from Canada which had meanwhile increased its calcining capacity to keep up with the sudden increase in its mine output resulted in more than doubling the importation of calcined material.

REVENUE.

Since magnesite has always been on the free list, the Government has never gained any revenue from its importation. The imports for consumption since 1907 are as follows:

Imports for consumption.

MAGNESITE, CRUDE.

Fiscal years.	Rates of duty.	Quantities (pounds).	Values.	Duties collected.	Value per unit of quantity.
1907	Free	44,648,557	$156,722.00		$0.004
1908	do	42,722,846	141,992.00		.003
1909	do	20,725,355	39,558.00		.002
1910	do	34,175,514	108,623.25		.003
1911	do	37,951,190	127,341.00		.003
1912	do	29,415,095	88,482.00		.003
1913	do	33,654,260	111,276.00		.033
1914	do	21,590,605	46,611.00		.002
1915	do	37,463,509	89,625.00		.002
1916	do	101,591,459	281,620.00		.003
1917	do	179,292,638	748,951.00		.004
1918	do	18,532,767	104,947.00		.006

Imports for consumption—Continued.

MAGNESITE, CALCINED, NOT PURIFIED.

Fiscal years.	Rates of duty.	Quantities (pounds).	Values.	Duties collected.	Value per unit of quantity.
1907	Free	143,891,572	$698,715.45		$0.005
1908	do	146,860,775	706,088.00		.004
1909	do	186,961,370	871,383.80		.005
1910	do	225,895,904	1,026,982.00		.005
1911	do	296,225,507	1,362,120.00		.005
1912	do	204,997,478	990,241.00		.005
1913	do	345,322,155	1,731,443.00		.005
1914	do	288,989,577	1,485,273.00		.005
1915	do	125,893,407	751,766.00		.006
1916	do	32,372,610	282,768.00		.009
1917	do	9,448,817	182,037.00		.019
1918	do	22,764,029	535,202.00		.024

PRICES.

The price statistics for magnesite are somewhat complicated because of the variety of grades and methods of packing. Except for Austrian dead-burned material, the different products have not been well standardized and statistics for successive years are not comparative. Magnesite "raw" and "calcined" are the only two classes quoted in trade journals with any degree of regularity. But these quotations are nominal and rarely reflect even major fluctuations.

Before the war, the lowest prices for dead-burned Austrian magnesite were $15.72 f. o. b. docks at Philadelphia, $15.60 f. o. b. New York, and $15.20 f. o. b. New Orleans. These figures represent the practical minimum prices that had been reached in 15 years. In rough figures the average price of calcined magnesite along the Atlantic seaboard was $16.25 per net ton. An approximately average freight rate from Atlantic points to Chicago was $2.40 a ton, yet the lowest f. o. b. Chicago price quoted for the material in 1914 was $26 per short ton.

The minimum prewar price of raw magnesite was $8 per net ton on the Atlantic seaboard and was usually quoted higher. Material (Grecian) calcined for medicinal and other uses ranged from $20 to $25 per ton according to its purity and the care that had been exercised in sorting. Fine ground calcined brought up to $35 and $40. Little information can be gained by a study of the import valuations except that they bear out the fact that shipments from Europe, except from the producing countries are of material especially ground and packed. Magnesite from the United Kingdom has the highest valuation ($49.40 per ton in 1914), while the Austrian material is valued at $9 to $10 and the Grecian imports were generally valued at slightly over $10.

The only quotations for the domestic product before the war were in California. In general they did not differ greatly from the quotations for imported magnesite in the East. In the early years of the war, San Francisco became the dominant market. Quotations rose from $22 to $25 per ton for crude calcines in sacks and $40 to $55 for the ground product in paper lined barrels.

Prices of magnesite, 1913.

[Wholesale, per short ton.]

NEW YORK MARKET.

Grecian, Eubœan, calcined "caustic," fine ground (in paper-lined barrels)	$25.00 to $35.00
Grecian, Eubœan, calcined "caustic," not ground (in sacks)	17.50 to 20.00
Grecian, Eubœan, crude (bulk)	7.00 to 8.00
Austrian, calcined, dead-burned, crushed or fine ground (bulk)	16.15 to 16.25

PACIFIC COAST MARKETS (SAN FRANCISCO OR LOS ANGELES).

Domestic, calcined, "caustic," fine ground (in paper-lined barrels)	$30.00 to $35.00
Domestic, calcined, not ground, dead-burned (in sacks)	20.00 to 25.00
Norwegian, calcined, dead-burned, crushed or fine ground	22.50

TARIFF HISTORY.

Magnesite, both crude and calcined, has been free since 1883. The tariff history may be tabulated as follows:

Act of—	Paragraph.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	620	Magnesite, or native mineral carbonate of magnesia	Free.
1890	640	do	Do.
1894	543	do	Do.
1897	[1] 605	Magnesite, crude or calcined, not purified	Do.
1909	618	do	Do.
1913	539	do	Do.

[1] As passed by the House of Representatives the provision read: "Magnesite, or native mineral carbonate of magnesia, all not medicinal." The change to the wording as enacted was made in the Senate.

COURT AND TREASURY DECISIONS.

In a decision in 1876, ground magnesite, or native carbonate of magnesia, composed of magnesia 47.6 and carbonic acid 52.4, was classified as carbonate of magnesia, although differing in some respects from the more common article known by that name. (Dept. Order, T. D. 2875.)

Calcined magnesite, declared to have all the characteristic properties of cement and to be used as a mortar in cementing magnesite bricks, was classified as cement under the act of 1883. (T. D. 9375.)

An importation described as "calcined magnesite, or magnesite which has been reduced to pulverization by heat and then ground," and chiefly used as a cement for lining furnaces, was held not within the provision in the act of 1894 for "magnesite, or native mineral carbonate of magnesia," nor gypsum ground or calcined, but dutiable as cement other than Roman, Portland, or hydraulic. (G. A. 3370, T. D. 16851.)

A similar importation was classified as cement by the customs officers under the act of 1897, but the Board of General Appraisers held it exempt from duty as "magnesite, crude or calcined, not purified," a broader provision than that in the former law. (G. A. 5003, T. D. 23316.)

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PRODUCERS IN 1918 AND CHARACTER OF PRODUCT.

CALIFORNIA:

Piedra Magnesite Co., Fresno (calcined).
J. H. Plattner, Livermore (crude).
Sinclair Bros. & Ferguson, Piedra (calcined).
Bay Cities Water Co., Coyote (crude).
Western Magnesite Development Co., 519 California Street, San Francisco (crude and calcined).
Gustine Magnesite Co., Ingomar (crude).
Red Mountain Magnesite Co., Marine Building, San Francisco (crude and calcined).
Standard Magnesite Co. of California, 244 California Street, San Francisco (crude).
E. Duryee, 1205 Hollingsworth Building, Los Angeles (crude).
H. T. Haden, Dinuba (crude).
Oakland Magnesite Co., Realty Syndicate Building, Oakland (crude).
Harker Magnesite Co., Guerneville (calcined).
Fred Leighton, Cloverdale (crude).
Nichelini & McKenzie, Chiles (crude).
J. D. Hoff Asbestos Co., Monadnock Building, San Francisco (calcined).
R. Schiffman, Pasadena (crude).
C. G. Gohlin, St. Helena (crude).
Hugo Fischl, Hollister (crude).
H. Sherlock, Madrone (crude).

The following were believed to be operating at the end of 1918:

Frank R. Sweasy (White Rock mine), Humboldt Bank Building, San Francisco (crude and calcined).
Wellman-Lewis, 901 Hibernian Building, Los Angeles (crude and calcined).
Sonoma Magnesite Co., Humboldt Bank Building, San Francisco (crude and calcined).
Tulare Mining Co., 310 Sansome Street, San Francisco (crude and calcined).
Porterville Magnesite Co. of California, Porterville (crude and calcined).

WASHINGTON:

American Mineral Production Co., 622 Insurance Exchange Building, Chicago, Ill.
Northwest Magnesite Co., Hutton Building, Spokane.
(Both these companies are operating—February, 1919—and produce both crude and calcined).